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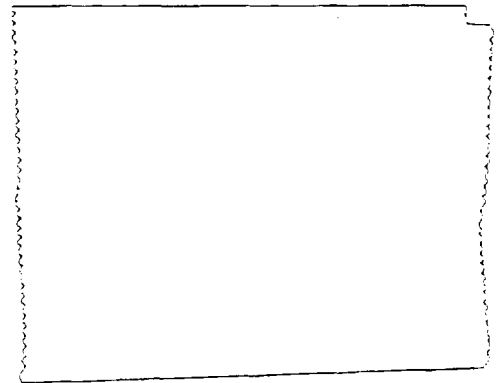
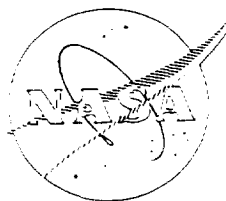


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EDITION

DOCUMENTATION GUIDELINES FOR NEW TECHNOLOGY REPORTING



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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PREFACE

Date: April 1969

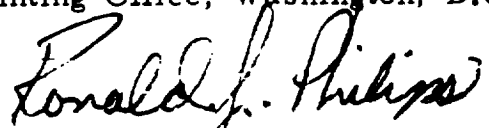
This Handbook provides documentation guidelines to New Technology Representatives and Technology Utilization personnel, in both NASA and NASA contractor organizations, and will be made available to other technical personnel in the respective organizations as appropriate.

These guidelines are being published to provide a better understanding of the information desired by NASA as part of a full and complete technical disclosure on reports of inventions, discoveries, improvements, and innovations. As such, they are intended to aid those persons responsible for documenting or submitting new technology to NASA.

General documentation criteria and detailed documentation guidelines are provided herein in generic terms as they are applicable to all types of information which may be reported into the NASA Technology Utilization Program. Unique guidelines for specific disciplines are also discussed briefly.

Additional information on new technology reporting and the Technology Utilization Program is contained in "Management Guidelines for New Technology Reporting to NASA" (NHB 2170.1), or may be obtained by contacting the Technology Utilization Officer at any NASA Field Installation. Copies of this Handbook and of NHB 2170.1 are available to the public from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

NHB 2170.2 is hereby canceled.


Ronald J. Phillips, Director
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CHAPTER 1: INTRODUCTION

100 PURPOSE OF THE NASA TECHNOLOGY UTILIZATION PROGRAM

The immense scope and complexity of U.S. aerospace research and development efforts has brought about a large and valuable resource: useful new technology. To realize the full potential of this resource--to encourage its broad and effective use outside the sphere of its original application--is the task of the NASA Technology Utilization Program. The program has four principal purposes:

1. To maximize the return on the public investment in aerospace research and development by encouraging secondary applications of the results of that research and development.
2. To shorten the time gap between the discovery of new knowledge and its effective use in the commercial marketplace and in other sectors of the economy.
3. To encourage the transfer of new knowledge across disciplinary, regional, and industry lines, so that the optimum value will be reaped from the investment in the generation of this knowledge.
4. To contribute to the development of improved means of transferring technology from its point of origin to its many points of potential use.

101 TECHNOLOGY TRANSFER PREREQUISITES

Technology transfer can occur only if two very basic and important initial steps are taken. These two steps are:

1. Novel and significant advances in science and technology resulting from NASA-sponsored research and development efforts must be identified.
2. Such advances must then be fully and carefully documented in a form that permits understanding of those advances by a spectrum of potential users.

Technology transfer cannot begin until these two steps have been taken.

102 NEW TECHNOLOGY REPORTING

NASA, through its Technology Utilization Program, provides for the evaluation, publication and dissemination of new technology identified and reported by the various NASA field installations and their contractors/grantees. All NASA research and development contracts contain either a New Technology Clause or a Property Rights in Inventions Clause

obligating each contractor to actively search for, identify, document and report promptly to NASA all new technology (. . . "inventions, discoveries, improvements, or innovations") resulting from work performed during the course of the contract. Reports submitted in accordance with these clauses (hereinafter referred to as "New Technology Reports") should describe fully the nature, purpose, operation and physical characteristics of each identified item of new technology. Similarly, NASA Management requires NASA employees to promptly report new technology resulting from in-house research and development activities.

CHAPTER 2: DOCUMENTATION GUIDELINES

200 BASIC DOCUMENTATION CRITERIA

1. The National Aeronautics and Space Act of 1958 and all NASA research and development contracts require full and complete disclosures of those inventions, discoveries, improvements, or innovations resulting from NASA-sponsored research and development activities. Basic information usually considered necessary for each completely documented New Technology Report is governed by the following criteria:

Description

Criteria

1. A full description of the specific problem or objective that motivated the technology development.
2. A technically complete and easily understandable description of the new technology that was developed to solve the problem or meet the objective.
3. An identification and explanation of the unique or novel features of the new technology and a discussion of the results (or benefits) of its application.
4. The inclusion or listing of any pertinent references which aid in the understanding or application of the new technology.

These four broad information areas constitute the basic criteria for adequate new technology documentation and form general guidelines which should help to achieve:

- Rapid, effective, and efficient evaluation of New Technology Reports.
- A decrease in requests for additional information, which are time consuming and costly.
- Improved and timely preparation of NASA Technology Utilization publication media (such as NASA Tech Briefs, Compilations, and Technical Support Packages) and NASA Patent Applications (where applicable).
- More effective and rapid transfer of the technology to interested users.

2. The First Criterion requires that the documentation clearly indicate the circumstances or problems which motivated the development of the item of new technology. This includes background information, a description of systems or processes in which it is used or for which it is proposed, other attempts to solve the problem and shortcomings of these previous attempts, and the peculiar circumstances or environment which led to the need for the particular item.
3. The Second Criterion requires that the documentation provide a clear, explicit and accurate description of what the innovation is, what it consists of, and how it functions. NASA should be provided with:
 - Any graphics which might aid in illustrating the item of new technology and how it functions;
 - A description of any related test equipment, test procedures, set-up or construction procedures;
 - Any theoretical presentation required to explain the concept, design or function of the innovation and information helpful in illustrating and describing novel or unique features of the innovation; and
 - Any related maintenance, reliability, or safety factors, when appropriate.

This Criterion generally requires detailed, specific information. The relative complexity and sophistication of the technology determines the scope and depth of information required to fulfill this Criterion. All possible pertinent information should be made part of the documentation, including applicable parts or ingredient lists, component specifications, and engineering specifications.

4. The Third Criterion requires that the documentation identify the novel or unique features of the item and clearly present and discuss the results of any use or test results. This area of information should also support or substantiate any operational claims made for the item to permit NASA to clearly determine how effective the innovation was in its specific application. Without this information, it may be extremely difficult to determine how well the innovation might function in other applications or under other environmental conditions.
5. The Fourth Criterion requires that the documentation include, or refer to, any identifiable additional relevant information which can aid a reader in understanding, adopting, evaluating, or using the innovation. Bibliographies, additional publications of the information, NASA and/or contractor reports, and technical disclosures all provide NASA and any potential user with additional information inputs which can stimulate the technology transfer process. Bibliographies should only include publications which are generally available to the public.

201 DOCUMENTATION GUIDELINE ELEMENTS

1. It is apparent that the basic documentation criteria described in paragraph 200 are not complete guides by themselves. There are many sub-types of information which may be required to fulfill each

of the four criteria. These information sub-types, referred to herein as documentation guideline elements, are listed and discussed in subparagraphs 2 through 5.

The list of criteria and the elements is not intended to be either restrictive or exhaustive. If other information elements are available and relevant to effective documentation of an item of new technology, such additional elements should be included in the New Technology Report. (Only existing information and its documentation need be submitted. Documentation does not involve a request for the performance of any research and development to generate information not already in existence).

2. FIRST CRITERION--A FULL DESCRIPTION OF THE SPECIFIC PROBLEM OR OBJECTIVE THAT MOTIVATED THE TECHNOLOGY DEVELOPMENT

The New Technology Report should include a technically adequate description of the problem, project, or situation which led to the development of the new technology item. This description should include the following informational elements:

Elements

- 1A. An explicit, descriptive summary of the problem, project, or situation which motivated the development of the new technology.
- 1B. Discussion of any key or unique problem characteristics or requirements which led to its development.
- 1C. Past history of the problem, including prior theories, concepts, techniques, equipment, methods, materials, or processes used to attempt solution of the problem.
- 1D. Limitations or disadvantages of prior techniques, equipment, etc., which prevent them from providing an effective solution to the present problem.

3. SECOND CRITERION--A TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE DESCRIPTION OF THE NEW TECHNOLOGY THAT WAS DEVELOPED TO SOLVE THE PROBLEM OR MEET THE OBJECTIVE

The New Technology Report should include a technically complete and effective description of the item by presenting all available and pertinent information. A complete description will generally include the following informational elements:

Elements

- 2A. A brief description of the new technology item and its specific purpose.
- 2B. A statement regarding the extent to which it has been developed (e.g., concept, design, prototype, modification, production, etc.).

- 2C. A description of the operation and function of the item and any whole unit of which it is a part.
- 2D. A detailed functional description of subsystems, components, flows, subprocesses, subroutines, etc. and interrelationships thereof.
- 2E. Supportive theory, design, analytic, or computation equation, etc., required to illustrate or substantiate the function or purpose of the new technology.
- 2F. Engineering specifications, special design limitations, requirements, etc.
- 2G. Peripheral equipment, test equipment and procedures, required inputs and outputs, assembly equipment, set-up procedures, experimental procedures, processing or fabricating procedures, if peculiar to the new technology item.
- 2H. Block diagrams, circuit diagrams, engineering drawings, isometric or exploded view pictures, figures or sketches, photographs, graphs, tables, charts, flow charts, input/output formats, etc., clearly relating to 2A through 2G above, or required to understand the item being reported.
- 2I. Parts or ingredient lists, program listings, component specifications, component tolerances, etc.
- 2J. Maintenance, reliability, environmental requirements, personnel and safety factors.

4. THIRD CRITERION--AN IDENTIFICATION AND EXPLANATION OF THE UNIQUE OR NOVEL FEATURES OF THE TECHNOLOGY AND A DISCUSSION OF THE RESULTS (OR BENEFITS) OF ITS APPLICATION

The New Technology Report must attempt to identify the novel, or unique, features of the new technology and should clearly indicate the results of applying the technology to the problem or objective for which it was conceived or developed. The description of the novelty and applicability of the innovation will include the following informational elements where applicable:

Elements

- 3A. Explicit, detailed identification and discussion of those features of the new technology which are considered novel or unique.
- 3B. Developmental or conceptual problems encountered and how they were solved
- 3C. Operating characteristics, test data, preliminary results, etc., which illustrate results or performance.

- 3D. Clear analysis(es) of any test or operational data, or study conclusions illustrating the ability of the new technology to achieve its objectives or solve the problem.
- 3E. Identifiable or probable sources of error, technological weakness, and/or inaccuracy.
- 3F. Identifiable advantages and shortcomings of the item in its present, intended, or possible application. (Why does the new technology answer the problem need more effectively than known methods or devices?)
- 3G. Degree of technological significance exhibited by the item of new technology:
 - Modification to existing technology
 - Substantial advance in the art
 - Major breakthrough

5. FOURTH CRITERION--THE INCLUSION OR LISTING OF ANY PERTINENT REFERENCES WHICH AID IN THE UNDERSTANDING OR APPLICATION OF THE NEW TECHNOLOGY

The New Technology Report should include any available additional, pertinent, or applicable references and information. This information should generally include the following elements:

Elements

- 4A. Bibliographies indicating background information.
- 4B. Copies of pertinent technical journal articles, professional papers, lab notes, etc.
- 4C. Copies of pertinent:
 - Contractor Reports
 - Technical Notes
 - Technical Memoranda
 - Invention Disclosures

202 DOCUMENTATION MATRIX

1. GENERAL

Figure 1 presents a summary of the documentation guideline elements for various information types (see subparagraph 3b below) required to meet the basic documentation criteria. This "Documentation Matrix" is intended to be used as a checklist to aid those individuals preparing New Technology Reports. For each information type the Matrix illustrates those documentation elements usually required for a complete disclosure. The documentation guideline elements listed

DOCUMENTATION GUIDELINE MATRIX FOR SELECTED TYPES OF INFORMATION			TYPES OF INFORMATION									
			1	2	3	4	5	6	7	8	9	10
			SCIENTIFIC STUDIES/EXPERIMENTS	MATERIALS / CHEMISTRY	MECHANICAL/ELECTROMECHANICAL DEVICES OR SYSTEMS	ELECTRONIC CIRCUITS OR SYSTEMS	ELECTRICAL/ELECTRONIC COMPONENTS	COMPUTER PROGRAMS	MANAGEMENT TECHNIQUES OR SYSTEMS	TOOLS OR FIXTURES	PRODUCTION TECHNIQUES OR PROCESSES	TEST METHODS OR TECHNIQUES
DOCUMENTATION ELEMENTS												
1	PROBLEM DESCRIPTION	GENERAL DESCRIPTION OF PROBLEM/OBJECTIVE	A									
		KEY OR UNIQUE PROBLEM CHARACTERISTICS	B									
		PAST HISTORY/PRIOR TECHNIQUES	C									
		LIMITATION OF PRIOR TECHNIQUES	D									
Documentation elements (1A through 2A) should be satisfied for all types of information												
2	TECHNICAL DESCRIPTION & ILLUSTRATIONS	SPECIFIC DESCRIPTION OF ITEM	A									
		STATE OF DEVELOPMENT (CONCEPT, DESIGN, ETC.)	B	X	X	X	X	X	X	X	X	X
		OPERATION AS A UNIT	C	X	X	X	X	X	X	X	X	X
		OPERATION/FUNCTION (FLOWS, SUBSYSTEMS, ETC.)	D	X	X	X	X	X	X	X	X	X
		SUPPORTIVE THEORY	E	X	X	X	X	X	X	X	X	X
		ENGINEERING SPECS, DESIGN REQUIREMENTS OR LIMITATIONS, ETC.	F	X	X	X	X	X	X	X	X	X
		PERIPHERAL EQUIPMENT, TEST PROCEDURES, SET-UP PROCEDURES, ETC.	G	X	X	X	X	X	X	X	X	X
		DRAWING, DIAGRAMS, SCHEMATICS, GRAPHS	H	X	X	X	X	X	X	X	X	X
		PARTS OR INGREDIENTS LIST	I	X	X	X	X	X	X	X	X	X
		MAINTENANCE, RELIABILITY, SAFETY FACTORS, ENVIRONMENTAL REQUIREMENTS	J	X	X	X	X	X	X	X	X	X
3	NOVEL OR UNIQUE FEATURES	NOVEL OR UNIQUE FEATURE	A	X	X	X	X	X	X	X	X	X
		DEVELOPMENTAL OR CONCEPTUAL PROBLEMS ENCOUNTERED AND SOLVED	B	X	X	X	X	X	X	X	X	X
		OPERATING CHARACTERISTICS, TEST DATA	C	X	X	X	X	X	X	X	X	X
		ANALYSIS OF CAPABILITIES	D	X	X	X	X	X	X	X	X	X
		SOURCES OF ERROR OR INACCURACY	E	X	X	X	X	X	X	X	X	X
		ADVANTAGES / SHORTCOMINGS	F	X	X	X	X	X	X	X	X	X
		DEGREE OF TECHNOLOGICAL SIGNIFICANCE	G	X	X	X	X	X	X	X	X	X
4	ADDITIONAL REFERENCES	BIBLIOGRAPHIES	A	X	X	X	X	X	X	X	X	
		COPIES OF PERTINENT PAPERS, ARTICLES	B	X	X	X	X	X	X	X	X	X
		COPIES OF CONTRACTOR REPORTS, PATENT DISCLOSURES, ETC.	C	X	X	X	X	X	X	X	X	X

FIGURE 1

X. GENERALLY INCLUDED GENERALLY NOT INCLUDED

on the matrix are merely short form notations. To gain fuller understanding of the scope of each element, the user should refer to the more complete element descriptions provided in paragraph 201.

2. USE OF THE MATRIX

To use the matrix one should first determine in which of the 10 information types his new technology item generically falls. For example:

- a. A New PERT Sliderule is clearly a management aid; however, in generic terms, it is a tool. Therefore, TYPE 8 - TOOLS OR FIXTURES more properly delineates the documentation guideline elements ascribed to such a device rather than TYPE 7 - MANAGEMENT TECHNIQUES OR SYSTEMS.
- b. A Simple Active Filter Using Tantalum Thin Film Technology could conceivably fall under TYPE 5 - ELECTRICAL/ELECTRONIC COMPONENTS or TYPE 2 - MATERIALS/CHEMISTRY. The predominant feature here appears to lie in the application of existing tantalum thin film technology to the development of a new filter. Therefore, TYPE 5 - ELECTRICAL/ELECTRONIC COMPONENTS would be the most likely selection and the documentation guideline elements ascribed thereto would be most appropriate.
- c. A research project whose ultimate objective was to improve the simulation of the solar spectrum as observed in space, yielded first a Variable Spectrum Radiation Source, and second, a better understanding of line and continuum radiation physics. The radiation source would be documented according to TYPE 3 - MECHANICAL/ELECTROMECHANICAL DEVICES OR SYSTEMS, whereas the new knowledge gained about radiation physics would be documented as TYPE 1 - SCIENTIFIC STUDIES/EXPERIMENTS.

3. MATRIX INTERPRETATION

- a. The documentation guideline elements have been phrased so as to enable them to apply, as far as possible, to all information types. Although in a large number of cases all of these elements should be satisfied, it will become apparent in scanning the 10 information types in subpar. b below that certain of the documentation elements are likely to be inapplicable or unnecessary for most new technology falling within a particular information type. For example, a comprehensive contractor report or supportive theory would most likely not be necessary for a new tool, and parts or ingredient lists would obviously not be applicable to scientific studies.
- b. A synopsis of the documentation guideline elements usually to be included or omitted for each information type follows:

TYPE 1-SCIENTIFIC STUDIES/EXPERIMENTS

Documentation for scientific studies and experiments obviously will contain a high concentration of theoretical, supportive information, experimental procedures and analysis of experimental

results. Operation, both in functional and overall terms, is inapplicable and the documentation should not be molded to attempt a contrived satisfaction of these guideline elements (2C and 2D). Engineering specifications and parts or ingredient lists are totally unnecessary, even if available to describe peripheral equipment employed in experimentation (photographs or illustrations should suffice). Experimental results, as opposed to operating characteristics or test data per se (element 3C) should be included. Analysis of capabilities (element 3D) should be interpreted to include study conclusions and recommendations. Sources of error or inaccuracy in experimentation might be included, but are not generally as critical as with operational technology. Such information would most likely be discussed under element 3F, Advantages/Shortcomings. Special care should also be taken to include copies of pertinent additional references such as journal articles, symposium papers, technical reports and memoranda, etc.

TYPE 2-MATERIALS/CHEMISTRY

In the materials/chemistry area, operational descriptions (elements 2C and 2D), and engineering specifications (element 2F) are inappropriate. Sources of error or inaccuracy (element 3E) are usually unnecessary in this area as advantages/shortcomings (element 3F) is considered sufficiently comprehensive. Applicable processing or fabricating procedures should be included as part of guideline element 2G documentation. Where a study or analysis of properties or characteristics of existing materials is being reported, descriptions of processing or fabricating procedures would clearly be inappropriate. While maintenance and reliability features will usually be inapplicable, any environmental requirements and safety factors are clearly relevant and should be included (element 2J). Rather than operating characteristics per se, guideline element 3C should include chemical properties and characteristics. Available additional references are important in this area, and, as in Type 1 above, should be included.

TYPE 3-MECHANICAL/ELECTROMECHANICAL DEVICES OR SYSTEMS

All documentation guideline elements should normally be satisfied for mechanical/electromechanical devices or systems. Critical subsystems and subparts will often be found in this area, thus leading to the necessity for discussion of both the overall operation and functional description in terms of subparts and subsystems (elements 2C and 2D)--supported by details such as engineering specifications and/or circuit diagrams (element 2F), where applicable. Special care should be taken to distinguish between novelty in a subpart or component and the overall device or system element (3A). As this is perhaps the broadest information type listed, almost any information relevant to any of the guideline elements should be submitted.

TYPE 4-ELECTRONIC CIRCUITS OR SYSTEMS

In most cases, all of the documentation guideline elements should be satisfied for electronic circuits or systems. Expanding on the

generic element descriptions in the matrix, guideline element 2F (engineering specifications) should be interpreted to include special design limitations and requirements. Element 2H would obviously include circuit schematics with appropriate values indicated, as well as system block diagrams and graphic presentations of input-output characteristics. Element 2I (parts or ingredient lists) would refer to component specifications and requirements. While bibliographies (element 4A) would be superfluous for simple circuits, they should be included for complex electronic systems involving technology unfamiliar to large segments of industry.

TYPE 5-ELECTRICAL/ELECTRONIC COMPONENTS

The very nature of this technical area usually requires that operation of the component as a unit be stressed (element 2C). A functional description in terms of subsystems and subprocesses (element 2D) will often appear irrelevant for components, and therefore need not be separately described. In cases where the function of the component cannot be clearly understood from an overall description of the unit, supportive theory (element 2E) should be expanded to cover subparts (critical material characteristics, etc.). Engineering specifications (element 2F), in this technical area, refers more specifically to component tolerances and design limitations. Naturally, any applicable charts, graphs, and tables relating to component operating characteristics and the application of such components in circuit schematics should be included where appropriate (element 2H). Parts or ingredient lists (element 2I), even for complex components, are considered inappropriate. Bibliographies (element 4A) will, for most components, be superfluous, but should be included if complex theoretical considerations are important to an understanding of the function of the component.

TYPE 6-COMPUTER PROGRAMS

In the computer program area, a large number of specific terms of art have arisen which accurately describe specific documentation which would satisfy the documentation guideline elements. Functional operation (element 2D) here refers to a description in terms of flows, subprocesses and subroutines. Description of peripheral equipment (element 2G) should include machine and language requirements. Drawings, diagrams, etc. (element 2H) more specifically refers to flow charts, input/output formats, etc. Rather than a parts or ingredients list per se (element 2I), this documentation guideline element is satisfied by the inclusion of a program listing. When available, the tapes or card decks should be supplied. Operating characteristics (element 3C) should be interpreted to include run instructions. In the computer program area, state of development (element 2B) need not be indicated as it is assumed that the existence of the completed program indicates that it is operational. Maintenance and safety factors (element 2J) are inapplicable to the program itself, notwithstanding that the computer or peripheral equipment might bear on these factors. Bibliographies may be useful if a relatively unknown programming

technique is employed, but will not usually be essential to an understanding of the program and should therefore not ordinarily be prepared. While copies of pertinent articles and papers relating to the program itself should be enclosed, more detailed reports involving, for example, projects for which the program was developed, should not be included in the documentation.

TYPE 7-MANAGEMENT TECHNIQUES OR SYSTEMS

Management techniques or systems, like the more traditional types of information, can be considered to fall within the same generic guideline element descriptions as presented in the matrix. Items in areas such as systems analysis and design, activity sequencing, data collection and analysis, operation research, PERT, reliability assurance and quality control, etc., all require overall operational and functional descriptions (elements 2C and 2D). Supportive theory (element 2E) might include management sciences or statistical theory underlying the reported technique or system. Peripheral equipment test and set-up procedures (element 2G) are considered to be important, including for example a description of hardware useful in supporting management (specific visual display systems, etc.). Engineering specifications, operating characteristics, and parts or ingredient lists of such equipment would usually be superfluous, and are otherwise inapplicable to management techniques. Capability analysis (element 3D), sources of error or inaccuracy (element 3E), as well as the advantages or shortcomings (element 3F), are considered to be especially important in relating the capacity of the management technique or system to achieve its objective(s).

TYPE 8-TOOLS OR FIXTURES

Items falling in this category are usually fairly simple and straightforward, therefore requiring a relatively small amount of documentation. While an operational description (element 2C) is necessary, a detailed functional description concerning subsystems, components, etc. (element 2D) is considered superfluous. Likewise, supportive theory (element 2E) required for more complex technology will not be necessary. Peripheral equipment and test procedures (element 2G), as well as parts lists (element 2I) may be available, but usually need not be submitted due to the item's relative simplicity. Criteria 3, Novel or Unique Features, can be satisfied with a brief delineation of novel or unique features (element 3A), advantages and shortcomings (element 3F), and an assessment of technological significance (element 3G). Detailed information on operating characteristics (element 3C), capability analysis (element 3D), and developmental or conceptual problems (element 3B), do not materially aid in understanding the tool or fixture, and should not ordinarily be furnished. While patent disclosures (element 4C) would be useful, other detailed reports (elements 4A and 4B) relating to the tool or fixture usually do not add significantly to the understanding of these devices, and therefore should not be included.

TYPE 9-PRODUCTION TECHNIQUES OR PROCESSES

All of the documentation guideline elements should usually be satisfied for production techniques or processes. Emphasis in the technical description will often be in the operational area, although supportive theory may be important for especially complex processes. All types of drawings, graphs, etc. (element 2H) may be applicable as might be engineering specifications (element 2F), parts or ingredients lists (element 2I), peripheral equipment (element 2G), and maintenance, reliability and safety factors (element 2J). All available information should be carefully considered for submission. Bibliographies will probably be useful only for complex processes or where the technology depends heavily on a understanding of relevant prior art, and should not be prepared otherwise.

TYPE 10-TEST METHODS OR TECHNIQUES

Documentation for test methods or techniques usually requires emphasis in the areas of overall operational description, test specifications and requirements, test and set-up procedures, and reliability and safety factors (elements 2C, 2F, 2G, 2J). In most cases, the technology will not require supportive theory (element 2E) for a full understanding, nor will it be sufficiently complex to require a detailed functional description (element 2D). Likewise, parts or ingredients lists (element 2I) are inapplicable. Test data (element 3C) is usually unnecessary for an understanding of the method or technique and should be included only if essential to an appreciation of such things as reliability or environmental requirements. As with production techniques, bibliographies are considered unimportant except for unusually complex techniques or where the technology depends heavily on an understanding of relevant prior art.

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CHAPTER 3: GENERAL GUIDELINES

300 PREPARATION OF DOCUMENTATION

It is apparent that all of the documentation guideline elements described in paragraphs 201 and 202 cannot, or should not, be documented for every report of new technology. Two basic questions should be asked by those preparing such documentation: (1) which guideline elements generally require documentation?--and, (2) in what depth of detail should they be documented? The following general guidelines can provide answers to these questions:

1. If information helps describe the new technology--what it is, how it functions, why it is novel, what it does, how it might be used--it should be included in submitted documentation.
2. Provide information for the documentation elements at a depth of detail sufficient to make the point clear and explicit. Vague, unclarified, nonspecific, or unsubstantiated information makes evaluation and publication preparation difficult, if not impractical. Remember that a point which is obvious to the innovator may not be obvious to someone seeking to employ the technology for a different purpose.
3. Review critically the information gathered for a particular innovation. If there are apparent unanswered questions, e.g., "How well did it perform or meet the technical objective?" attempt to retrieve this information--quantitative data where possible--for inclusion in the New Technology Report.
4. Document all elements for which information is already available or easily obtained. This guideline is based on the philosophy that evaluation and transfer are easier if fewer guesses have to be made by the evaluator or potential user.
5. Avoid the use of slang terms, jargon, or abbreviations in the documentation of new technology. When undefined, these may seriously impede the evaluation and publication process.

301 LEGIBLE COPY GUIDELINES

Legible copy, for the purpose of the NASA Technology Utilization Program, is defined as text, printed material, and illustrations which can be easily read and readily reproduced.

The following guidelines are presented to ensure the legibility of descriptive text and illustrations.

1. Descriptive Text

- a. Typewritten copy is the most convenient method to use in preparing legible reports. If properly prepared, it will make an excellent master copy for most types of reproduction processes. Either the original manuscript or good reproducible copies, may be submitted.
- b. Printed copy such as research/laboratory results, contractor reports, Technical Memoranda, etc., should be included, when available, as part of the documentation. If these reports include halftone photographs, copies of the glossy prints should be submitted, when available, in the event the report must be reproduced for further dissemination.
- c. Diazo and mimeograph types of reproducible copy are generally acceptable for submission of new technology documentation. Care should be taken, however, to be sure that the copy is very distinct and free from smudges; only first-run copies should be submitted.
- d. Hectograph or "Ditto" types of copy require special effort to ensure that pages are free of smudges and all letters are distinct. Extra care in typing should be taken and only first-run copies should be submitted. USE OF THIS PROCESS SHOULD BE AVOIDED IF PRACTICAL.
- e. Photostat copy often has uneven tone quality which make reading and reproduction difficult. THIS IS GENERALLY NOT ACCEPTABLE.
- f. Carbon copy may be submitted if it is clear and free of smudges. However, such copy is undesirable because fuzzy letters make legible reproduction difficult. GENERALLY, THIS IS NOT ACCEPTABLE.

2. ILLUSTRATIONS

- a. All graphs, charts, schematics, detailed drawings, photos, and the text of the documentation should be clear, distinct, uncluttered, and readable. (Photographs should not be reproduced by xerography process.)
- b. Illustrations which accompany the descriptive text must be clear, and the lettering, dimensions, and callouts must be legible. Any portion of an illustration discussed or described in the New Technology descriptive text should be clearly labelled by callouts. Line drawings may be drawn directly on manuscript pages if they are not complex. Drawings should have sufficient weight in all lines to permit legible photographic reproduction. Photostats (positives) of line drawings which have even tone quality and sharp lines and letters and reproducible copies of drawings are acceptable.

- c. Glossy photographs, preferably size 8 in. x 10 in. photographs should be handled with care. Avoid writing on the print or on the tissue overlay used to protect it, since the resulting indentations in the emulsion may appear in the reproduction. Paper clips should not be used to hold pictures to the text. Avoid fingerprints. Planographed copies of photographs are also acceptable.
- d. Oversize illustrations such as engineering reproducibles are acceptable as documentation material. Special care should be taken to see that these illustrations are not vague, faded, torn, or otherwise illegible or difficult to reproduce.

3. REFERENCES

NASA Special Publications SP-7007, "Repro, Typing and Layout," and SP-7008, "Technical Illustrating," present NASA suggestions for the proper preparation of reports and illustrations. These two publications should be referred to for guidelines to acceptable physical layout of documentation. These publications may be obtained from NASA Technology Utilization Officers, NASA Contracting Officers, or from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

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CHAPTER 4: NEW TECHNOLOGY DOCUMENTATION FORMS

400 NASA FORM 666--NEW TECHNOLOGY TRANSMITTAL

1. For each item of new technology reported to NASA, a New Technology Transmittal Form (NASA Form 666) (BuBud Approval No. 104-R0046) is available from the designated new technology representative. This form provides for the submission of critical information available only to the submitting organization, such as names and locations of innovators; availability of documentation; state of development; previous publication; and origin and contract under which the new technology was conceived, developed or initially reduced to practice.
2. If utilized, the NASA Form 666 (see Figure 2) shall be prepared by the reporting NASA or NASA contractor organization. The form can be regarded as in two sections, one (items 1 through 11, and item 19) to be completed by representatives of the organization where the new technology was conceived, developed or initially reduced to practice; the second (the control number, items 12 through 18, and item 20) to be completed by NASA Technology Utilization personnel, as appropriate for processing the new technology items.

401 NASA FORM 666A--NEW TECHNOLOGY REPORT

1. NASA Form 666A, New Technology Report Form (see Figure 3), is for the optional use of the person submitting or documenting the item of new technology. It contains 4 sections, keyed to these Documentation Guidelines, for aiding the originator (innovator) of new technology in providing adequate documentation.
2. Other forms, such as those which may already have widespread use within a contractor organization may be used provided that the essential information requested on the NASA Form 666A is supplied.
3. This form is designed to be conveniently filled out by the originator (innovator) of the technology, who should attach additional documentation where necessary.



CARD (CC 1-3) <div style="border: 1px solid black; padding: 2px; display: inline-block;"> <div style="display: flex; justify-content: space-around; width: 100%;"> 23 </div> <div style="display: flex; justify-content: space-around; width: 100%; font-size: 0.8em;"> 123 </div> </div>	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION NEW TECHNOLOGY TRANSMITTAL (See Instructions on Reverse)	Approved Through January 1970 Budget Bureau No. 104-R0046 NT CONTROL NUMBER (CC 4-11) <div style="border: 1px solid black; padding: 2px; display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 2px;"> <div style="display: flex; justify-content: space-around; width: 100%;"> </div> <div style="display: flex; justify-content: space-around; width: 100%; font-size: 0.8em;"> 456 </div> </div> <div style="border: 1px solid black; padding: 2px;"> <div style="display: flex; justify-content: space-around; width: 100%;"> </div> <div style="display: flex; justify-content: space-around; width: 100%; font-size: 0.8em;"> 7891011 </div> </div> </div>																																	
1. TITLE <div style="text-align: center; font-weight: bold; font-size: 1.2em;">Brake Control System</div>																																			
2. INNOVATOR(S) (Name and Social Security No.) <div style="text-align: center; font-weight: bold;">John T. Masters (129-08-0032)</div>																																			
3. EMPLOYER (Organization and division) <div style="text-align: center; font-weight: bold;">Advanced Systems, Inc. Aerospace Division</div>		4. ADDRESS (Place of performance) <div style="text-align: center; font-weight: bold;">1400 Cherry Lane Louisville, Kentucky 54321</div>																																	
5. DOCUMENTATION (Full and complete disclosure must be enclosed, the contents of which are discussed in NHB 2170.3, Documentation Guidelines for New Technology Reporting. Place an "X" to the left of those items of documentation which are available but NOT enclosed with this transmittal)																																			
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<table style="width: 100%; border-collapse: collapse;"> <tr> <td rowspan="4" style="width: 10%; vertical-align: middle; text-align: center;">PUBLICATION</td> <td style="width: 10%; border: 1px solid black;">TYPE</td> <td colspan="2" style="border: 1px solid black;"> <input type="checkbox"/> JOURNAL <input checked="" type="checkbox"/> REPORT <input type="checkbox"/> CONFERENCE OR SEMINAR </td> <td style="width: 10%; border: 1px solid black;">BY</td> <td colspan="2" style="border: 1px solid black;"> <input type="checkbox"/> NASA <input type="checkbox"/> OTHER GOVT. <input checked="" type="checkbox"/> CONTRACTOR </td> </tr> <tr> <td style="border: 1px solid black;">VOLUME NO.</td> <td style="border: 1px solid black;">PAGE</td> <td style="border: 1px solid black;">DATE</td> <td colspan="2" style="border: 1px solid black;">STATUTORY BAR ESTABLISHED (Date)</td> </tr> <tr> <td style="border: 1px solid black;">ASC 8</td> <td style="border: 1px solid black;">15 +</td> <td style="border: 1px solid black;">2/15/69</td> <td colspan="2" style="border: 1px solid black;"></td> </tr> <tr> <td colspan="5" style="border: 1px solid black;">TITLE ATS Satellite Stabilization Syst. Dev.</td> </tr> <tr> <td rowspan="2" style="vertical-align: middle; text-align: center;">PATENT</td> <td style="border: 1px solid black;">STATUS</td> <td style="border: 1px solid black;">NO.</td> <td colspan="3" style="border: 1px solid black;">DATE</td> </tr> <tr> <td style="border: 1px solid black;"><input type="checkbox"/> APPLICATION FILED <input type="checkbox"/> ISSUED</td> <td style="border: 1px solid black;"></td> <td colspan="3" style="border: 1px solid black;"></td> </tr> </table>			PUBLICATION	TYPE	<input type="checkbox"/> JOURNAL <input checked="" type="checkbox"/> REPORT <input type="checkbox"/> CONFERENCE OR SEMINAR		BY	<input type="checkbox"/> NASA <input type="checkbox"/> OTHER GOVT. <input checked="" type="checkbox"/> CONTRACTOR		VOLUME NO.	PAGE	DATE	STATUTORY BAR ESTABLISHED (Date)		ASC 8	15 +	2/15/69			TITLE ATS Satellite Stabilization Syst. Dev.					PATENT	STATUS	NO.	DATE			<input type="checkbox"/> APPLICATION FILED <input type="checkbox"/> ISSUED				
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8. ORIGIN (CC 12) <div style="border: 1px solid black; padding: 2px; display: inline-block; font-weight: bold;">P</div> 9. NASA PRIME CONTRACT NO. (CC 13-23) <div style="border: 1px solid black; padding: 2px; display: inline-block;"> <div style="display: flex; justify-content: space-around; width: 100%;"> NAS3 </div> <div style="display: flex; justify-content: space-around; width: 100%; font-size: 0.8em;"> 1314151617181920212223 </div> </div>																																			
10. SUBCONTRACT TIER (CC 24) <div style="border: 1px solid black; padding: 2px; display: inline-block; font-weight: bold;">12</div> 11. CONTRACTOR REPORTABLE ITEM NO. (CC 25-33) <div style="border: 1px solid black; padding: 2px; display: inline-block;"> <div style="display: flex; justify-content: space-around; width: 100%;"> ASC143 </div> <div style="display: flex; justify-content: space-around; width: 100%; font-size: 0.8em;"> 24252627282930313233 </div> </div>																																			
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20. APPROVED (Center Tied) <div style="border: 1px solid black; padding: 2px; display: inline-block;"> <div style="display: flex; justify-content: space-between; width: 100%;"> NAME SIGNATURE DATE </div> <div style="display: flex; justify-content: space-between; width: 100%;"> </div> </div>																																			

NASA FORM 666 SEP 66 PREVIOUS EDITIONS ARE OBSOLETE.

FIGURE 2--FRONT

INSTRUCTIONS

1. **TITLE.** Title of new technology (Innovation, invention, discovery or improvement). If item is classified, note security classification.
2. **INNOVATOR(S).** Innovator's full name and Social Security Number.
3. **EMPLOYER.** Company, university, research institute, or Government agency name and division.
4. **ADDRESS.** Employer's address, including city, State and ZIP Code (Place of Performance). If more than one contributing organization, indicate name and address of each.
5. **DOCUMENTATION.** This section should be used as a checklist for available descriptive material which appears to be not essential for a basic understanding of the new technology item (i.e. what is it; what is it good for; why is it better?) and which may be costly to reproduce or handle and which has therefore not been enclosed with this transmittal, but could be supplied if requested. Place an "X" to the left of the phrase or phrases describing such documentation.
6. **PREVIOUS PUBLICATION AND PUBLIC DISCLOSURE.** If the transmitted new technology has been described, in full or in part, in a conference or seminar; or in a previously published report, journal, patent application or patent; or in a paper submitted for publication in any of the above, the appropriate boxes should be checked and indicated source of information supplied. The earliest such publication or disclosure establishes a statutory bar; therefore, this date should be given where indicated.
7. **STATE OF DEVELOPMENT.** An "X" should be placed opposite the appropriate phrase or combination thereof which adequately describes the state of development of the new technology (e.g., concept, design, prototype, modification, production model, used in current work).
8. **ORIGIN** (cc 12). By one of the codes listed below, the type of effort under which the new technology was conceived, developed or initially reduced to practice should be indicated:

- ☐ **P** - NASA prime contract (Interagency transfer of funds included)
- ☐ **S** - Subcontract
- ☐ **N** - NASA in-house
- ☐ **J** - Joint effort of NASA prime contractor and NASA in-house
- ☐ **M** - Multiple contractor contribution reflecting a collaborated effort between a prime contractor and a subcontractor

- ☐ **A** - AEC (No NASA funds involved)
- ☐ **D** - DOD (No NASA funds involved)

9. **NASA PRIME CONTRACT NUMBER** (cc 13-23). The NASA contract number under which the new technology is transmitted should be cited in the space provided, as outlined below:

The alpha prefix should be written starting at the left box (cc 13), and then moving to the right (i.e., left justified).

The numeric prefix (i.e., the number immediately preceding the hyphen) should be placed in the box(es) immediately preceding the hyphen.

The numeric suffix (i.e., the number following the hyphen) should be written as far to the right as possible in the boxes (cc 18-23) following the hyphen (i.e., right justified). Only significant digits should be cited; and spaces should be left where appropriate.

Examples:

N	A	S		1	-			1	2	3	4
N	A	S	1	2	-	1	2	3	4	5	6
N	A	S	W		-	1	2	3	4	5	6
S	N	P			-	1	2	3	4	5	6
A					-	1	2	3	4	5	6
N	G	R	3	5	-			1	0	0	2
N	A		1		-	1	2	3	4	5	6
13	14	15	16	17		18	19	20	21	22	23

10. **SUBCONTRACT TIER** (cc 24). Tier number (1,2,3, etc.) should be indicated if the new technology is transmitted under a NASA subcontract effort. The NASA prime contract number indicating the prime contract effort under which the subcontract was let should also be completed as outlined above. (item 9.)
11. **CONTRACTOR REPORTABLE ITEM NUMBER** (cc 25-33). Originator's internal control number, assigned to each item submitted in accordance with the New Technology/Property Rights and Inventions Clause, should be inserted in the boxes provided, starting with box cc 25, if assigned.
19. **PREPARED BY.** The name of the individual preparing the transmittal form (New Technology Representative or designated equivalent), his signature and the date of preparation should be entered in the space provided.

INSTRUCTIONS FOR SHADED AREAS

Card Number (cc 1-3); NT Control Number (cc 4-11); Items 12 through 18 and item 20 are to be completed by NASA Technology Utilization personnel or designated alternates.

GPO 942-885

FIGURE 2 -- BACK

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION NEW TECHNOLOGY REPORT		NT CONTROL NO. (Official use only)
INSTRUCTIONS		
<p>This report form may be used when reporting inventions, discoveries, improvements or innovations to NASA. Use of this report form is optional; provided, however, that whatever report format is used contain the essential information requested herein.</p> <p>Please provide information requested in each section as follows:</p> <p style="margin-left: 40px;">Section I - A description of the problem that motivated the technology development.</p> <p style="margin-left: 40px;">Section II - A technically complete and easily understandable description of the new technology that was developed to solve the problem or meet the objective.</p> <p style="margin-left: 40px;">Section III - The unique or novel features of the technology and the results (or benefits) of its application.</p> <p style="margin-left: 40px;">Section IV - The inclusion or listing of any pertinent additional documentation or references which aid in the understanding or application of the new technology.</p> <p style="margin-left: 40px;">In completing each section, use whatever detail deemed appropriate for a "full and complete disclosure," as required by the New Technology or Property Rights in Inventions Clause. For further guidance as to what constitutes a satisfactory report, please refer to NHB 2170.3, Documentation Guidelines for New Technology Reporting.</p> <p style="margin-left: 40px;">Available additional documentation which provides a full, detailed description should be attached, as well as any additional explanatory sheets where necessary.</p>		
1. TITLE <div style="text-align: center; padding: 5px;">CW Laser System</div>		
2. INNOVATOR (S) (Name and Social Security No.) <div style="text-align: center; padding: 5px;"> Russell Targ 072-11-4131 </div>		
3. EMPLOYER (Organization and division) Sylvania Electronic Systems Electronic Defense Laboratories	4. ADDRESS (Place of performance) Mountain View, California	
5. NASA PRIME CONTRACT NO. NAS 8-20558	6. CONTRACTOR DISCLOSURE NO. S5724	
SECTION I - DESCRIPTION OF THE PROBLEM THAT MOTIVATED THE TECHNOLOGY DEVELOPMENT (Enter A - General Description of Problem Objective; B - Key or Unique Problem Characteristics; C - Past History/Prior Techniques; D - Limitations of Prior Techniques)		
<p>The objective of this program is the design and development of a CW laser system in which the unique feature will be high power, single-frequency output in the S-20 (visible) photocathode response region. The developmental work on this laser system is motivated by the need for improved communications and radar systems where direct detection is employed.</p> <p>For many communications and radar applications the conventional free-running laser is more like a special kind of optical noise source than it is like an optical carrier. These uncontrolled lasers oscillate at a large number of optical frequencies simultaneously, and the oscillating modes have time-varying relative phases and amplitudes. The beats and competition between these modes are among the principal causes of noise in the output of the laser.</p> <p>In this program, our task has been to eliminate these major sources of noise in the laser output, with minimum sacrifice of total laser output power.</p> <p>To minimize the effects of random frequencies and noise, single frequency lasers have been used. While these devices have partially solved the problem, available single-frequency lasers are characterized by low power output due to side-band mode suppression.</p>		

NASA FORM 666A APR 69

Figure 3

SECTION II - TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE DESCRIPTION OF NEW TECHNOLOGY THAT WAS DEVELOPED TO SOLVE THE PROBLEM OR MEET THE OBJECTIVE (Enter as appropriate A.-Specific description of item; B.-State of development; C.-Operation as a unit; D.-Functional operation; E.-Supportive theory; F.-Engineering specifications; G.-Peripheral equipment; H.-Drawings, graphs, etc.; I.-Parts or ingredients lists; and J.-Maintenance, reliability, safety factors)

The innovation is an FM laser that eliminates the major source of noise in the output by compressing the individual frequencies into a single-frequency FM optical signal. This innovation performs an optical carrier function better than the conventional single-frequency laser by utilizing the sidebands with an FM technique, and permitting the energy of the bands to be recombined in an external modulator.

1. Ring discharge excitation with separate external RF power supply.

A one-watt ring-discharge argon laser used in the CW laser program is powered by an external 5 kw RF supply at 10 MHz. All other ring-discharge lasers have been designed in such a manner as to require the inclusion of the RF supply in the same package as the laser itself. We consider this combination detrimental to the best functioning of both components. The packaging of laser and power supply together increases the size, complexity and heat load of the laser, whereas separate packaging allows the optical alignment of the laser to be optimized without design compromises imposed by included RF circuitry. Also, the separate RF supply can be serviced without disturbing the laser or its optical system.

In our laser system, the RF exciter is connected to the laser by means of flexible coaxial cables and standard HN connectors. The link coupling and auto transformer that permit this separation of RF supply and laser are fully described in the additional documentation referenced in Section IV of this New Technology Report. Considerable care and ingenuity were exercised in the design of this circuit to prevent excessive RF voltages and currents from circulating in the cables and connectors. The resulting system has such an efficient transfer of energy from supply to laser that ordinary bidirectional power meters can be inserted at either end of the coaxial line to measure the forward and reflected RF power to the laser.

2. Single frequency operation of an Argon laser.

By a unique combination of an Argon laser and electro-optic elements, we have obtained 350 mw of single frequency light in the visible region of the spectrum. This is the most single frequency power yet obtained in this wavelength region suitable for detection with electron multiplier phototubes.

This single frequency power was obtained by first modifying a multimode Argon laser in order to make it operate as an FM laser. This was accomplished by inserting an electro-optic phase modulator containing KDP in the laser cavity. When this modulator is driven at three times the laser's axial mode interval $3(c/2L)$, the modes of the laser become locked in FM phases. The output of the laser is then an FM signal, with the same power as the free running laser, reduced only by the insertion loss of the modulator itself.

The FM output of the laser is then sent through an external phase modulator consisting of the electro-optic material LiNbO_3 , heated to 180°C to prevent the incoming light from making it opaque. This modulator produces a modulation equal to that of the FM laser, but 180° out of phase. The result of this second modulation is to compress all the energy in the sidebands of the FM signal into the optical carrier, and thus give a single frequency output at the same power as the original laser.

Figure 3--Cont.

SECTION II (Con.)

SECTION III - UNIQUE OR NOVEL FEATURES OF THE TECHNOLOGY AND THE RESULTS (OR BENEFITS) OF ITS APPLICATION (Enter as appropriate A.-Novel or unique features; B.-Development or conceptual problems; C.-Operating characteristics, test data; D.-Analysis of capabilities; E.-Source of error; and F.-Advantages/shortcomings)

The FM laser system has several novel features: (1) separate packaging of the laser and the RF power supply, (2) unique combination of a one-watt ring-discharge argon laser with electro-optic elements to provide 350mw of single-frequency light in the visible spectrum, (3) use of KDP electro-optic phase modulator, driven inside the laser cavity and driven at three times the axial mode interval, to lock the laser modes into FM phases, (4) the use of an external phase modulator, consisting of the electro-optic material LiNbO_3 , to compress all the energy in the sidebands of the FM signal into the optical carrier, the single-frequency FM laser output.

The potential applications of the single-frequency FM laser include communications and radar where direct detection is desired. As the power output of the laser is improved, welding and fabrication applications may be feasible.

Figure 3--Cont.

SECTION III (Con.)				
SECTION IV - ADDITIONAL DOCUMENTATION (Include or list below any pertinent documentation which aids in the understanding or application of the new technology. IF NOT TOO BULKY OR DIFFICULT TO REPRODUCE, INCLUDE COPIES WITH THIS REPORT. For those references or additional documentation available but NOT included in this report (due to their being nonessential to a basic understanding of the new technology and which may be costly to reproduce or handle) complete item A. below)				
A. AVAILABLE DOCUMENTS (Check and complete)	<input checked="" type="checkbox"/>	1. PAPERS, ARTICLES	<input type="checkbox"/>	4. ASSEMBLY/MFG. DRAWINGS
	<input checked="" type="checkbox"/>	2. CONTRACTOR REPORTS	<input type="checkbox"/>	5. PARTS OR INGRED. LIST
	<input type="checkbox"/>	3. ENGINEERING SPECS.	<input type="checkbox"/>	6. OPERATING MANUALS
	7. TEST DATA			
			<input type="checkbox"/>	8. ASSEMBLY/MFG. PROCED.
			<input type="checkbox"/>	9. COMPUTER TAPES/CARDS
10. OTHER (Specify)				
B. INDICATE THE DATES OR THE APPROXIMATE TIME PERIOD DURING WHICH THIS TECHNOLOGY WAS DEVELOPED (i.e., conceived, constructed, tested, etc.)				
First conceived in March 1966. Development proceeded during ensuing year.				
C. LIST THE FIRST PUBLICATION OR PUBLIC DISCLOSURE OF THE NEW TECHNOLOGY, AND DATES				
"Single Frequency Light from an Argon FM Laser," Osterink and Targ, Applied Physics Letters, Feb. 15, 1967.				
D. LIST THE DATES AND ANY PARTICULARLY PERTINENT PAGE NUMBERS OF OTHER PUBLICATIONS WHICH ARE AVAILABLE BUT NOT ATTACHED				
"CW Laser System for the Generation of Single-Frequency Light," Final Report under Contract No. NAS 8-20558, March 1, 1967.				
E. DEGREE OF TECHNOLOGICAL SIGNIFICANCE (Check in your best judgment the statement which best expresses the degree of technological significance of this technology)				
<input type="checkbox"/> 1. MODIFICATION TO EXISTING TECHNOLOGY		<input checked="" type="checkbox"/> 2. SUBSTANTIAL ADVANCE IN THE ART		<input type="checkbox"/> 3. MAJOR BREAKTHROUGH
COMMENTS				
SIGNATURE OF INNOVATOR(S)				DATE 03-02-67

GPO 874-181

Figure 3--Cont.

APPENDIX A: DOCUMENTATION EXAMPLES

This appendix contains examples of effective documentation for each of the documentation guideline elements. The examples have been chosen from a wide range of scientific and technical areas and have further been chosen to show the broad range of types and depth of information required in various areas.

Diverse examples of individual guideline element documentation have been appended rather than a single well-documented New Technology Report satisfying all the guideline elements, so as not to create the impression that each item of new technology should have the same depth of documentation. Reference should be made to the Documentation Matrix in paragraph 202 and other sections of this Handbook for guidelines as to the documentation usually required for a particular type of information.

Examples of all documentation elements except 2B, 3G, and 4A-4C have been included. The documentation content of these latter elements are thought to be sufficiently clear so as not to require further illustration in this handbook.

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1. EXAMPLE OF DOCUMENTATION FOR FIRST CRITERION

A DESCRIPTION OF THE PROBLEM THAT MOTIVATED THE TECHNOLOGY DEVELOPMENT

Elements: 1A - "An explicit, descriptive summary of the problem, project, or situation which motivated the development of the new technology."

1B - "Discussion of any key or unique problem characteristics or requirements which led to its development."

1C - "Past history of the problem, including prior theories, concepts, techniques, equipment, methods, materials, or processes used to attempt solution of the problem."

1D - "Limitations or disadvantages of prior techniques, equipment, etc., which prevent them from providing an effective solution to the present problem."

"A test program was undertaken at the Lewis Research Center to investigate the dynamics of hydrogen-oxygen fuel-cell systems. In the type of system presently being studied, the water produced in the cells is removed in vapor form by a recirculating stream of hydrogen. This type of fuel cell is discussed in reference 1. A portion of the test program planned for this system consists of introducing controlled disturbances into the humid-hydrogen stream that enters the fuel cell and studying the effects of these disturbances on its operating parameters. In order to study the effects on the fuel-cell water-removal processes, it is necessary to know, on a continuous basis, the humidity (steam-to-hydrogen mass ratio) of the hydrogen stream leaving the fuel cell. Because of the nature of the planned tests, the instrument to be used for measuring the recirculating stream humidity, in addition to being a continuous-reading device, has to have a certain speed of response. Since a measurement technique or a humidity transducer with the required speed of response could not be found, the Research Laboratories Division of The Bendix Corporation was contracted by NASA Lewis to design and develop an instrument based on a fluidic-oscillator concept. This concept utilizes the fact that the frequency of oscillation of a fluidic oscillator is dependent on the molecular weight of the fluid medium. In a two-component mixture, such as hydrogen-steam, the molecular weight, in turn, depends on the mass ratio of the components."

1A

1B

1C

1D

This example was taken from New Technology Report: Lewis-340 - "Use of Fluidic Oscillator as a Humidity Sensor"



2. EXAMPLES OF DOCUMENTATION FOR SECOND CRITERION

A TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE
DESCRIPTION OF THE NEW TECHNOLOGY THAT WAS DEVELOPED TO
SOLVE THE PROBLEM OR MEET THE OBJECTIVE

Element: 2A - "A brief description of the new technology item and its
specific purpose."

"The device is basically an optical projector which projects visual limits of the human eyes. It consists of two projector housings, as shown in figure (1), each of which are capable of pivoting the same degree as the human eye and head, thus allowing the system to optically project the human visual limits at any distance and direction desired. The projector housings each contain an optical system which uniformly illuminates a slide upon which is an image representing the visual limits of each eye. The images combine into one at the point where the optical axis of both projectors converge with each other. Eye accommodation is simulated by focus adjustment on each projector."

This example was taken from New Technology Report: WOO-250 - "Envelope Optical Projector"

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Element: 2C - "A description of the operation and function of the item, and any whole unit of which it is a part."

"A diagram of the optical superheterodyne receiver is shown in Figure 1. The optical system consists of a Mersenne telescope¹, with two concave, confocal paraboloidal reflectors. The received rays are reflected from the tracking mirror to the primary parabolic mirror and thence to the secondary beam-forming parabola. The signal is then mixed with the local signal at the mirror adder and the resultant beat detected by the photomultiplier.

The receiver uses a precision angle tracking servo-controlled mirror² to maintain alignment between the incoming signal and the receiver telescope. Another optical signal takeoff provides angular data to an image dissector photo-multiplier to control the tracking mirror.

The beat-frequency output of the photomultiplier is fed to a 30-MHz, 4-MHz intermediate frequency amplifier and thence to a limiter-discriminator combination. The low-frequency output of the discriminator output is amplified and used to control the local oscillator to provide automatic frequency control. The local oscillator is a voltage-tuned Spectra Physics, Inc. Model 119 single-frequency laser. Initial search and frequency acquisition is performed manually. An FM and AM coherent signal output is provided in addition to a noncoherent output to measure optical power. Interference type optical filters are used in front of both the receiver and tracking detectors.

The receiver optics are shown in Figure 2 and the electronics are shown in Figure 3. In addition to the necessary electronics, a multichannel tape recorder with buffer amplifiers to record signal data during experiments is also shown."

¹ King, Henry C. The History of the Telescope, Sky Publishing Corp., Cambridge, Massachusetts, 1959.

² R. F. Lucy, C. J. Peters, E. J. McGann, and K. T. Lang, "Precision Laser Automatic Tracking System," Applied Optics, vol. 5, pp. 517-524; April 1966.

This example was taken from New Technology Report: M-FS-2398 - "Optical Superheterodyne Receiver"

Element: 2D - "A detailed functional description of subsystems, components, flows, subprocesses, subroutines, etc., and interrelationships thereof."

"System Description

1. Transmitter

The monitor signal generator/transmitter's output is composed of two discrete frequencies, amplitude modulated at a sub-audio frequency. Two levels of modulation are provided to furnish channel idle or busy information to the monitor receiver. The transmitted monitor signal level is just enough above the normal received noise level to insure reliable performance. As shown in Figure 1, the monitor signal generator is made up of seven sections. These seven sections comprise a complete transmitter; however, economy and simplicity will be gained in multi-unit installations if the oscillators are made common to all units. The seven sections and a brief functional description of each follow:

- Lower frequency oscillator
- Upper frequency oscillator
- Lower frequency power amplifier and modulator
- Upper frequency power amplifier and modulator
- Sub-audio frequency oscillator
- Isolation and coupling amplifier
- Communications signal detector

a. Lower and Upper Frequency Oscillators

The lower and upper frequency oscillators generate the two frequencies (200 and 3200 cps in Figure 1) which are used to monitor channel quality. There are no special design requirements for these oscillators. Their frequency stability determines, in part, the bandwidth occupied by the monitor signals and the selectivity (or band pass) of the receiver; therefore, their frequency stability should be as high as is economically feasible. The frequency generated should be adjustable by means of straps to permit fitting the monitor signals to the bandwidth of particular communication channels.

b. Power Amplifier and Modulator

The power amplifier and modulator stages are used to isolate the oscillators from outside influence and to permit amplitude modulation without frequency modulation. The power output of these amplifiers is low (less than 1 mw); therefore, the design will consist of a single stage (one transistor) and its associated networks. The major requirement is linearity.

c. Sub-Audio Frequency Oscillator

The sub-audio frequency oscillator is used to modulate the monitor signal frequencies. The sub-audio frequency is recovered at the receiver and used to determine phase delay distortion and to notify the receiver when the communication channel is in use to permit noise measurements. The bandwidth required to transmit the modulated monitor signal frequencies is at least four times the frequency of the sub-audio frequency oscillator. For this reason, the sub-audio frequency should be as low as practicable; however, the time required to detect abnormal phase shift also depends on this frequency, so that a technical as well as an economic compromise will be required in its selection. No excessive stability is required for this oscillator.

d. Isolation and Coupling Amplifier

The isolation and coupling amplifier is used to isolate the monitor signals from the communication equipment, to allow manual adjustment of the transmitted monitor signal level, and to make up any loss caused by coupling the monitor signal to the communication channel. This device has no special design requirement, and if the communication signal level can be increased enough to compensate for the coupling loss, the isolation and gain control can be accomplished by passive networks (transformer and pads).

e. Communication Signal Detector

The communication signal detector rectifies and filters the communications signal to apply a dc signal to the sub-audio frequency oscillator. The dc signal increases the output of the oscillator and this increase is detected in the receiver to determine when the communication channel is in use. This circuit has no special design requirements, but a rapid attack time is desirable."

This example was taken from New Technology Report: KSC-66-38 - "Communication Channel Quality Monitor."

Element: 2E - "Supportive theory, design, analytic, or computation equations, etc. required to illustrate or substantiate the function or purpose of the new technique."

"The occurrence of cavitation in a curved pipe can be explained by examining the forces on an element of fluid as it passes through the bend. As the surface curves away from the element, an inward force must act on it to keep it against the inner surface. The outer wall pressure cannot increase; hence, the pressure difference required to keep the particle against the inner surface must be supplied by a reduction in the inner wall pressure. The maximum pressure difference is attained when the inner surface pressure has fallen to the vapor pressure of the liquid. However, if the outward radial velocity component of the particle has not fallen to zero, the pressure difference is not great enough to cause the particle to follow the path of the bend. Therefore, it separates from the inner wall and cavitation occurs (Ref. 1). This phenomenon is depicted by the test results shown in FIGURE 4.

Cavitating flows are described by the cavitation index or number:

$$\sigma = \frac{P_s - P_v}{\frac{1}{2} \rho \bar{v}^2}$$

where P_s is the upstream static pressure, P_v the vapor pressure at the bulk liquid temperature, ρ the mass density, and \bar{v} the upstream mean velocity. The critical cavitation index, σ_k , is defined by:

$$\sigma_k = \frac{P_k - P_v}{\frac{1}{2} \rho v_k^2}$$

The upstream static pressure at cavitation is P_k , the mean critical velocity at which cavitation occurs is v_k , and P_v and ρ as before.

CAVITATION SIMILARITY LAWS

The similarity laws for curved pipe flow can be explained in the same manner as those for flow about a body. At some point within a pipe bend, a maximum flow velocity is reached with a corresponding minimum pressure. A minimum pressure coefficient is defined as

$$C_{P_{\min}} = \frac{P_s - P_{\min}}{\frac{1}{2} \rho \bar{v}^2}$$

At the point of cavitation inception, for geometrically similar flow systems, the ratio of the pressure difference $P_s - P_{\min}$ to the upstream dynamic pressure is equal to the minimum pressure coefficient in the non-cavitating flow regime (Ref. 2). Therefore, the assumption that the minimum pressure equals the vapor pressure and that the minimum pressure coefficient equals the critical cavitation index at cavitation inception makes equation 3 identical to equation 2.

The scaling laws (similarity laws) employed in this study are briefly outlined below:

(1) Maintain a constant ratio between the inertial and viscous fluid forces - Reynolds number.

$$R = \frac{\rho \bar{v} d}{\mu}$$

(2) Assuming a near gas-free liquid, maintain a constant ratio of the vapor pressure to the dynamic pressure,

$$\frac{P_v}{\frac{1}{2} \rho \bar{v}^2}$$

This scaling law can be used when all evaluations are made after cavitation inception. However, P_v will not necessarily be the vapor pressure at the bulk liquid temperature, because the vaporization of the liquid produces a cooling effect that lowers the vapor pressure. This reduction will be given by (Ref. 3).

$$\Delta P_v = \frac{\partial P_v}{\partial T} \Delta T$$

Hence, the scaling relationship should be $\Delta P_v / \frac{1}{2} \rho \bar{v}^2$. In this study the evaluation of the critical cavitation index was not always made at the same point within the cavitation region during every test; consequently, some tests produced significant cooling effects and others almost none. Due to this inconsistency, P_v was taken to be the vapor pressure at the bulk liquid temperature and equation 5 to be the scaling relationship.

Actually, there are other parameters that could cause departures from the scaling laws. No consideration was given to the effect of dissolved air and/or gas within the liquid, or to the effect of the surface tension of the liquid. Also disregarded are the time effects of bubble growth by diffusion associated with gaseous type cavitation, such as that presented by Ref. 3. No attempt was made to control the surface roughness or to vary fluid cleanliness to account for variations in the availability of bubble nucleation sites (Ref. 4). Unfortunately, it is impossible to isolate one scaling parameter and study its effects on cavitation."

This example was taken from New Technology Report: M-FS-517 - "Liquid Cavitation Studies in Circular Pipe Bends."

Element: 2F - "Engineering specifications, special design limitations, requirements, etc."

System Design Requirements

The closed-loop digital PU System shall be designed to meet the following design requirements:

- a. Load propellant masses, automatically, to within 1% of total propellant mass at first stage liftoff.
- b. Provide simultaneous depletion of propellant to within 575 pounds at engine cutoff.
- c. Provide inflight telemetry of the propellant masses during flight with an accuracy of 1%.
- d. Have the capability of automatic system checkout prior to liftoff.
- e. Provide biasing to insure sufficient fuel for boiloff during the coast period.
- f. Provide the capability of adjusting the nominal mixture ratio (during system calibration) to any value between 4.5:1 and 5.5:1.

Detailed Design Requirements

The improved mass measurement computer shall supply three outputs which are linear functions of sensor capacitance and therefore of propellant mass. These outputs are:

- a. LOX mass signal
- b. LH₂ mass signal
- c. PU error signal

Mass Signal Output

These outputs shall be in a parallel binary format suitable for input to the PCM telemetry. The resolution shall be 12 bits (0.025%).

a. Accuracy

1. Null Shift

The capacitance required to give a zero output shall not vary from the empty capacitance by more than:

LOX output $\pm 0.02\%$ of active capacitance
LH₂ output $\pm 0.04\%$ of active capacitance

Where:

The active capacitance is defined as the full capacitance minus the empty capacitance.

2. Linearity

The output shall be a linear function of sensor capacitance within the limits shown in figure 1. These limits do not include the quantization error.

3. Slope Error

The output slope, as given in figure 1, shall not deviate from its nominal value by more than 0.2%. This tolerance does not include the effects of quantization."

This example was taken from New Technology Report: M-FS-2459 - "Electronic PU System Concept."

Element: 2G - "Peripheral equipment, test equipment and procedures, required inputs and outputs, assembly equipment, set-up procedures, and experimental procedures, processing or fabricating procedures, if peculiar to the new technology item."

"System assembly"

The basic interconnections between the digital control subsystem, the analog computer and the dual-beam oscilloscope are given in Figure 1. The X, Y, and Z data inputs are connected to the three data inputs of the analog "and" gate shown in Figure 7. These are the only input signals to the digital control subsystem. The design center power supply voltages for the subsystem are plus and minus ten volts. The locations of the subsystem outputs shown in Figure 1 are shown in Figure 7.

The only connection to the oscilloscope from the control unit is the blanking signal. This signal is connected to the intensity-modulation input of the oscilloscope. The X-Y-Z gated data and axes from the digital control subsystem are entered in the analog computer at the points indicated in Figure 16. The computer gate is used as an external reset control for the analog computer.

The analog computer outputs are the solutions of the projection equations of Section II. An examination of these equations reveals that (30) and (32) are identical and only one need be implemented. Since most dual-beam oscilloscopes have provisions for signal inversion of the vertical inputs, the complement of (30) was programmed. This eliminated one amplifier. It should also be noted that the offset terms of (29) and (31) have been omitted. Again the oscilloscope can perform this offset function by adjustment of the horizontal position controls, the modified x_{rp} , x_{lp} and y_{rp} analog computer outputs

of Figure 1 are shown in the projection section of Figure 16. These outputs are connected into the oscilloscope as shown in Figure 1.

For proper stereoscopic viewing, the oscilloscope must be viewed through an optical adaptor. This adaptor is constructed using two non-color corrected lenses. A lens focal length of approximately 80 -cm has been found desirable. These lens are mounted on 7 -cm centers and placed 80 -cm from the face of the oscilloscope display. The tubular viewing hood normally supplied with oscilloscope systems is a satisfactory viewing hood.

Operation procedure

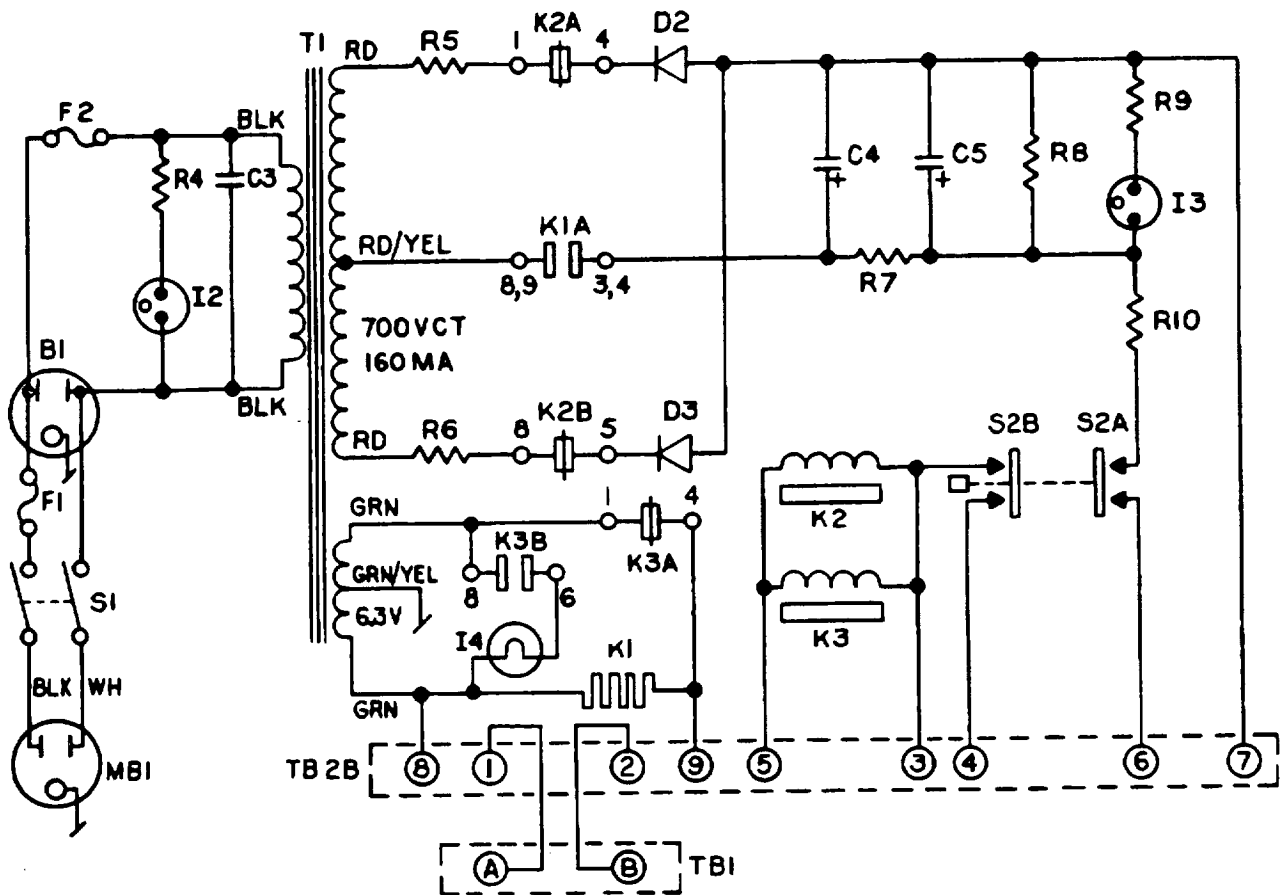
With no data inputs connected to the oscilloscope, adjust the horizontal and vertical controls until the two beams are centered vertically and are 7-cm apart. Next, adjust the X and Y input attenuators for a full scale deflection of approximately 1.5-cm. Connect the data outputs from the analog computer to the oscilloscope inputs. If rotation of the coordinate system is desired, select the particular axis of rotation by properly positioning the axis switch shown in Figure 16. Then set the resolver or resolver simulator to the desired rotation angle.

To facilitate convergence adjustment, a stationary pattern is desirable. A good test signal is generated by using a d-c level as the Y data input and two sinusoids that are 90 degrees out of phase as the X and Z data inputs. If rotation about the X axis is then chosen and a rotation angle of 45 degrees selected, the pattern shown in Figure 21 is observed. While viewing this pattern through the optical adaptor, adjust the oscilloscope horizontal controls for convergence and the resistor P1 as shown in Figure 16 for increased three-dimensional illusion. If P1 is set for zero volts at its arm, then the display will be planar. As the output of P1 increases, the three-dimensional illusion is increased. By varying the d-c level on the Y input, the circle is moved up and down the Y axis."

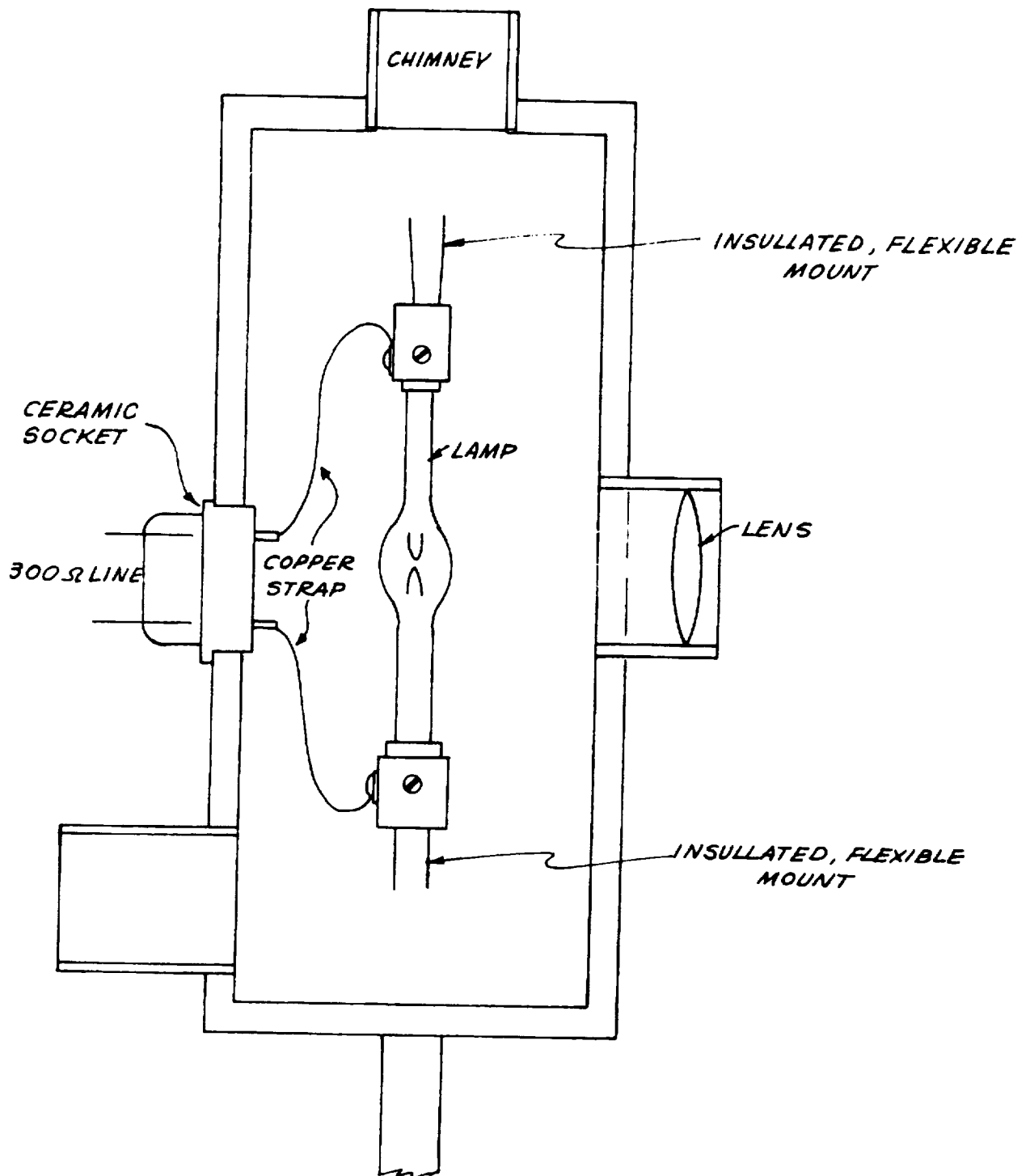
This example was taken from New Technology Report: M-FS-1263 - "Three-Dimensional Display."

Element: 2H - "Block diagrams, circuit diagrams, engineering drawings, isometric or exploded view pictures, figures, or sketches, photographs, graphs, tables, charts, flow charts, input/output formats, etc., clearly relating to 2A through 2G above, or required to understand the item being reported."

Schematic Diagram



Detailed Diagram



This example was taken from New Technology Report: JPL-421 - "Ignition System for Osram Lamp."

Element: 2I - "Parts or ingredients lists, program listings, component specifications, component tolerances, etc."

"B₁ - 3 wire grounded receptacle. (Primary power source for sustaining supply Harrison LAB 809A current mode or equivalent).

C₁ - 100 pf mica or glass 600V.

C₂ - 0.1 μ f ceramic 600V (5-0.02 μ f paralleled) or larger.

C₃ - 0.01 μ f oil filled paper 400V.

C₄ - 40.0 μ f 450 VDCW electrolytic (Sprague type FF-1).

D₁ - 1N1198A Select for $I_R < 10 \mu A$ $V_R = 600V$.

D₂, D₃ - 1N2617 Motorola.

F₁ - 3AG 5A SLO BLO.

F₂ - 3AG 1A SLO BLO.

I₁ - PEK 109 or similar.

I₂, I₃ - Neon Ne2 or equivalent.

I₄ - 6.3V Incandescent (G. E. #328).

K₁ - Amperite 6N0120T Time delay.

K₂, K₃ - Potter & Brumfield KRP11A. Rewound to pull in at ≈ 1.4 amperes.

MB₁ - 3 wire grounded motor base (plug).

L, L' - Belden 300 Ω Z Transmission line #8235.

R₁ - 1 Ohm 50 Watt. (Made from length of #14 nichrome selfsupporting 1 inch diameter.)

R₂ - 10 Ω D $\frac{1}{2}$ Watt carbon.

R₃ - 100 Ω Watt carbon.

R₄ - 47 K Ω $\frac{1}{2}$ Watt carbon.

R₅, R₆ - 10 Ω 2 Watt carbon."

This example was taken from New Technology Report: JPL-421- "Ignition System for Osram Lamp".

Element: 2J - "Maintenance, reliability, environmental requirements, personnel and safety factors."

"Care must be taken in fabrication of this unit. The 300 line of the oscillator is wound in a spiral of about 5 turns with approximately a 2 - 2 $\frac{1}{2}$ inch center radius. The oscillator tube is mounted at the center of this spiral along with its associated components. This allows for short leads from the plate and grid tap points. The connecting line is also of 300 parallel line and forms the rest of the line for the oscillator.

The leads in the lamp assembly are also very important. The input terminals should be on the side or rear of the lamp assembly and connected to the lamp via flat copper strap for best results. Leads may be brought in at the bottom or any point if required but the same connection methods must be followed internally, i.e., flat copper leads. Flexible coiled leads may not be used."

This example was taken from New Technology Report: JPL-421 "Ignition System for Osram Lamp."

3. EXAMPLES OF DOCUMENTATION FOR THIRD CRITERION

THE UNIQUE OR NOVEL FEATURES OF THE TECHNOLOGY AND THE RESULTS (OR BENEFITS) OF ITS APPLICATION

Element: 3A - "Explicit, detailed identification and discussion of those features of the new technology which are considered novel or unique."

"The novelty of the invention resides in the construction and configuration of the radiator/detector active element.

The novel characteristics of the instrument are:

1. The measurement does not depend on a Stefan-Boltzmann calculation or calibration as do all other absolute light measurement techniques.
2. It is a calorimetric measurement in which the calorimeter is operated isothermally (constant temperature), and the calorimeter constant (heat leak) is nulled out.
3. Like conventional thermopiles or bolometers, it may be operated in non-turbulent gas (air) or in a vacuum. Unlike conventional detectors, its heat leak rate, in watts, should be equal to or slightly more than its full range. This is the condition established when zeroing as described above.
4. It is a transfer standard in which the transfer is between light energy and electrical energy. Commercially available transfer standards compare electric energy generated by direct current. Alternating power, otherwise difficult to measure accurately, may thus be determined with the same precision as direct current power.
5. It may be used as a direct reading, absolute photometer requiring no calibration.
6. As a result of (2), the instrument has a rapid response and may be used to sense chopped or rapidly fluctuating light levels."

This example was taken from New Technology Report: JPL-521 - "A Rapid-Response Black-Body Cavity Radiometer."

Element: 3B - "Developmental or conceptual problems encountered and how they were solved."

"Another interesting interference phenomenon occurs within the fringe pattern from the interferometer. Besides the ordinary Michelson fringes there exists another fringe pattern which remains stationary with relatively large displacements of the micrometer screw (See Figures 19 and 20). At first it was thought that the source of the pattern was due to a spurious signal from the laser beam at a different wavelength. The two possible wavelengths of the laser beam are 6328 Angstroms and 6118 Angstroms. However, a prism in the beam and dispersing no other than the 6328 Angstroms is too small to visually effect the output.

Observation of the "stationary fringe pattern" yielded the following results.

- i) The pattern does not appear when the eye is looking into the laser interferometer. This was accomplished using neutral density filters.
- ii) The pattern disappears when a lens is placed before the interferometer.
- iii) Pattern disappears when either interferometer leg is blocked.
- iv) Pattern also disappears when the beam is entered skew.

The probable cause of the "stationary fringes" may now be understood to be a result of some sort of interaction between the laser spherical mirror, the two Michelson mirrors, and the beam splitter because as soon as one of these components are eliminated the fringes disappear.

If the micrometer drive is moved a distance greater than about 2 inches, the diameter of the shifting Michelson fringes changes. Hence, the cells within the fringe pattern arranged in quadrature do not remain 90 degrees out of phase. One possible solution of this problem is to use a pair of solar cells which lock them onto a stationary fringe in the manner shown in Figure 2. The differential signal can be used to drive a servo motor which in turn positions a negative lens at the output of the interferometer. The lens may be moved back and forth to keep the relative size of the Michelson fringes the same, and correspondingly, the quadrature signals."

This example was taken from New Technology Report: MSC-151 - "Precision Measuring Device Using a Laser-Interferometer."

Element: 3C - "Operating characteristics, test data, preliminary results, etc., which illustrate results or performance.

"Table III

Low Temperature Mechanical Properties of Aluminum Alloy

Sand Castings, -T6 Condition^(f)

Temperature °C	°F	Specimen ^(a) No.	U.T.S. ^(b) kai	Y.S. ^(c) kai	Elongation % in 4D	Fracture ^(d) Location
+26.7	+80	57-2-A-1	48.1	45.8	6.0	GL
		57-2-A-2	46.7	44.0	6.0	GL
		57-2-B-3	50.5	48.0	5.0	GL
		64-1-A-1	47.3	46.0	4.0	GL
		64-1-B-2	46.6	44.6	4.0	GL
		64-1-B-3	50.6	49.7	4.0	GL
		64-3-A-1	44.5	39.4	6.0	GL
		64-3-A-2	46.7	40.2	7.0	GL
		64-3-B-3	48.2	45.0	4.0	GL
		Average	47.7	44.7	5.0	
-73.4	-100	57-2-A-4	49.5	48.6	5.0	OEG
		57-2-A-5	51.3	49.9	5.5	GL
		57-2-B-6	53.9	52.5	4.0	CL
		64-1-A-4	48.1	48.1	2.0	GL
		64-1-B-5	50.8	49.3	4.0	GL
		64-1-B-6	50.5	48.0	3.0	GL
		64-3-A-4	43.4	41.2	6.0	GL
		64-3-B-5	47.6	44.2	-	OGL
		64-3-B-6	51.4	46.6	5.0	GL
		Average	49.6	47.6	4.3	
-129.0	-200	57-2-A-7	50.9	48.5	4.0	GL
		57-2-B-8	57.5	54.5	4.5	GL
		57-2-B-9	49.0	49.0	4.0	GL
		64-1-A-7	56.9	(e)	6.0	GL
		64-1-A-8	51.7	50.4	-	OGL
		64-3-A-7	43.9	43.6	3.0	GL
		64-3-A-8	48.6	46.2	6.0	GL
		64-3-A-9	47.5	41.9	8.0	GL
		Average	50.9	47.7	5.1	

^(a) Example: 57-2-A-13 means heat 57, casting number 2, test location area "A", test specimen 13.

^(b) U.T.S. - Ultimate tensile strength.

^(c) Y.S. - Yield strength, determined by .2% offset method.

- (d) EC - Extensometer clamp.
OEG - Outside extensometer gage length.
GL - Gage length.
OGL - Outside gage length.
- (e) Malfunction of extensometer prevented determination of yield strength.
- (f) -T6 condition was within Rockwell hardness range (RB) 72 to 76."

This example was taken from New Technology Report: M-FS-267 - "Miller-64, A New Aluminum-Copper Casting Alloy for Low-Temperature Service."

Element: 3D - "Clear analysis(es) of any test or operational data, or study conclusions illustrating the ability of the new technology to achieve its objectives or solve the problems."

"Tensile Properties

The tensile properties of the three aluminum alloy sand castings are shown in Table III and FIG 12. In all three castings, the tensile and yield strengths increased with decreasing temperature. The elongation, percent in 4D, did not appear to change much at temperatures as low as that of liquid nitrogen. However, a significant increase of elongation was observed at liquid hydrogen temperature.

Of the three castings tested, casting 57-2 had the best overall tensile properties. Castings 64-1 and 64-3 had slightly lower tensile and yield strengths than casting 57-2, particularly at cryogenic temperatures. Casting 64-3 had the poorest properties of the three castings tested. This variation of properties was attributed to inconsistent foundry methods and possible damage caused by improper heat treatment conditions.

Typical stress-strain diagrams and modulus of elasticity at temperatures ranging from ambient to liquid hydrogen are shown in FIG 13 and 14, respectively. The curves represent average values of three sand castings in the -T6 condition.

Microstructure

The microstructures of sand casting 57-2 are shown in FIG 15. These micrographs show large grains of various shapes with a discontinuous network of microconstituents along the grain boundaries. Dispersal of CuAl_2 particles occurred randomly throughout the matrix and grain boundaries. Dislocations that were apparent in some of the grains were attributed to internal stresses introduced during tensile loading.

The microstructures of sand casting 64-1 and 64-3 are shown in FIG 16. Segregation of microconstituents could probably be minimized by improving foundry methods and procedures. Gas porosity and microshrinkage were generally excessive.

Impact Properties

The low temperature impact properties of the three castings are listed in Table IV and are shown in FIG 17. In all three castings, the impact strength increased to an apparent maximum value at -196°C (-320°F) and then decreased slightly at -252.7°C (-423°F) to an average value greater than that measured at ambient temperature. It was evident that the characteristic toughness, as measured by impact strength, was affected adversely in the castings from heat 64. Foundry methods and/or heat-treatment conditions were again suspected.

Weldments

The weld strengths at low temperatures of the new aluminum alloy sand castings joined to aluminum alloy 2219-T87 (3/8-inch thick) plate are shown in Table V and FIG 18.

A significant increase of weld strength was observed in the temperature range of -129°C (-200°F) to -252.7°C (-423°F) with average values at these two temperatures of 38,500 psi and 49,400 psi, respectively.

The weld strengths at ambient temperature of castings joined to castings are shown in Table VI. The average strength was 25,700 psi in the as-welded condition. Reheat-treatment of a welded test sample almost doubled the strength. The low as-welded was attributed to the fact that the hardness of the castings, originally Rockwell B72 to B76, was reduced to an average value of RB 29.5 by the extended time at elevated temperature inherent in the manual welding procedure.

Comparison of Yield Strength and Impact Properties With Those of Several Other Alloys

The yield strength and impact properties of the new aluminum alloy are compared with those of three sand casting alloys which are presently used widely in space vehicles, Tens-50, A-356, and Almag 35 to illustrate the differences in properties among types of aluminum alloy sand castings at cryogenic temperatures. Data for this comparison are from previous investigations (Ref. 4) and from experimental work supplementary to the early programs related to the development of the new aluminum casting alloy (Ref. 5). This comparison was made on the average yield strength at room temperature and on the impact strength at liquid nitrogen temperature of aluminum alloys that were sand-cast without chills and heat treated with the exception of Almag 35, which is normally a non-heat-treatable alloy.

On the basis of the data shown in FIG 19, the new aluminum alloy was markedly superior in tensile yield strength and toughness, measured by impact strength at -196°C , to the other three commercial aluminum alloys.

CONCLUSIONS

Based on the test data derived from a limited number of castings, this new alloy is extremely promising for applications at cryogenic temperatures where high resistance to failure under dynamic loads is desired. In this respect, the alloy is superior to other high strength casting alloys such as Tens-50, A-356, and Almag 35. The alloy is readily weldable and is also heat-treatable.

Foundry methods and procedures used in making the casting were shown to have a definite effect on the low temperature properties. Like all high strength aluminum castings, close foundry control is necessary. A large commercial heat of this alloy has been ordered, and further evaluation will be made to determine the suitability of the alloy for commercial production."

This example was taken from New Technology Report: M-FS-267 - "Miller-64, A New Aluminum-Copper Casting Alloy for Low-Temperature Service."

Element: 3E - "Identifiable or probable sources of error, technological weakness and/or inaccuracy."

"The capability of this system to accurately measure distances as small as one eighth the wavelength of light at 6328 Angstroms was demonstrated (See data page). This corresponds to a distance of .00000311425 inches.

The micrometer drive of the slide could be driven by a servo motor desired. This would allow automatic displacement of the drive table at a specific rate. To decrease the average deviation of the data a micrometer drive screw with greater positioning accuracy could be employed. The error involved at present is due to the inability of the operator to position and read the position of the micrometer screw.

This example was taken from New Technology Report: MSC-151 - "Precision Measuring Device Using a Laser-Interferometer."

Element: 3F - "Identifiable advantages and shortcomings of the item in its present, intended, or possible application. (Why does the new technology answer the problem need more effectively than known methods or devices?)"

"This new method employs a strip of aluminum foil insulated from the base metal area that is to be leak-tested with a water-soluble paper. This two part assembly is to be pre-assembled with masking tape to hold the relationship of the foil and paper strips and at the same time hold these strips to the base metal. The insulating paper with the back-up aluminum foil strip is to be made wide enough to cover a weld and the desired amount of base metal heat affected zone. The masking tape holds this assembly in position over the weld.

When any minute amount of water leaks thru the weld or base metal into contact with the paper, the paper dissolves immediately and allows the water to activate a high resistant switching circuit between the base metal and the aluminum foil. This switching circuit would then activate a relay to sound an alarm and/or light up pilot lamps which may be used to indicate which tape/base metal circuit is leaking. The tapes would be divided into separate circuits according to the selected system effectivity. In the case of a bulk-head, for example, each meridian weld and each base to apex weld may be tested with separately taped circuits. When the alarm system indicates a leak, the location is noted and later when the hydrostatic pressure is removed, that tape will be removed and the location of the leak identified by the area of the paper that has been dissolved.

The system has the following advantages:

1. No dye or other critical additives need be used in the water.
2. Safety is enhanced since no inspection personnel need to be in the test area until after the pressure is removed. If desired the tape need not even be removed until the tank is drained.
3. No paints or other contaminants need to be applied to the exterior of the tanks to interfere with surface cleanliness.
4. The same water may be used for leak testing as is used for calibration purposes.
5. No black light or TV camera problems are involved with this system.
6. Standard available materials are used and can be pre-packaged into rolls of tape made up of the three basic components by a commercial tape fabricating firm. The power supply and indicator circuit panel can be fabricated from standard electrical components. Connections to the aluminum tape and to the base metal can be made by simple foil and wire connections."

This example was taken from New Technology Report: M-FS-362 - "Leak Detection System."